

CLAIMS

1. A method for allocating transmit power to a plurality of transmission
2 channels in a wireless communication system, comprising:

4 defining a set of one or more transmission channels to be allocated transmit
power;

6 determining a total transmit power available to allocate to the transmission
channels in the set;

8 allocating the total transmit power to the transmission channels in the set based
on a particular allocation scheme;

10 identifying transmission channels in a saturation region resulting from the
allocated transmit power;

12 reallocating each transmission channel in the saturation region with a revised
amount of transmit power;

14 determining a total excess transmit power for all transmission channels
reallocated with revised amounts of transmit power; and

16 performing the defining, determining, allocating, identifying, and reallocating
for one or more iterations, wherein the set of transmission channels for a first iteration
includes the plurality of transmission channels and for each subsequent iteration
18 includes transmission channels not in the saturation region, and wherein the total
transmit power available for each subsequent iteration includes the total excess transmit
20 power determined in a current iteration.

2. The method of claim 1, wherein the total transmit power available for
each iteration is allocated to the transmission channels in the set based on a water-filling
allocation scheme.

3. The method of claim 1, wherein a transmission channel is deemed as
2 being in the saturation region if it is allocated more transmit power than needed to
achieve a particular maximum data rate.

4. The method of claim 3, wherein the revised amount of transmit power
2 allocated to each transmission channel in the saturation region is a minimum amount
needed to achieve the maximum data rate.

5. The method of claim 1, wherein a transmission channel is deemed as
2 being in the saturation region if it is allocated more transmit power than needed to
achieve a particular signal-to-noise ratio (SNR).

6. The method of claim 5, wherein a single SNR is used for all transmission
2 channels in the set.

7. The method of claim 5, wherein each transmission channel is associated
2 with a respective threshold SNR.

8. The method of claim 1, wherein the identifying includes
2 determining an effective signal-to-noise ratio (SNR) for each transmission
channel in the set based in part on the transmit power allocated to the transmission
4 channel,
comparing the effective SNR for each transmission channel in the set to a
6 threshold SNR applicable to the transmission channel, and
declaring a transmission channel as being in the saturation region if its effective
8 SNR is greater than the applicable threshold SNR.

9. The method of claim 8, wherein the threshold SNR corresponds to an
2 SNR needed to achieve a particular maximum data rate.

10. The method of claim 1, wherein the wireless communication system is a
2 multiple-input multiple-output (MIMO) communication system.

11. The method of claim 10, wherein the plurality of transmission channels
2 correspond to a plurality of eigenmodes for a MIMO channel of the MIMO
communication system

12. The method of claim 1, wherein the wireless communication system is an
2 orthogonal frequency division multiplexing (OFDM) communication system.

13. The method of claim 1, wherein the wireless communication system is a
2 multiple-input multiple-output (MIMO) communication system that utilizes orthogonal
frequency division multiplexing (OFDM).

14. A method for allocating transmit power to a plurality of spatial
2 subchannels in a multiple-input multiple-output (MIMO) communication system,
comprising:

4 defining a set of one or more spatial subchannels to be allocated transmit power;
determining a total transmit power available to allocate to the spatial
6 subchannels in the set;

allocating the total transmit power to the spatial subchannels in the set based on
8 a particular allocation scheme;

10 identifying spatial subchannels in a saturation region resulting from the allocated
transmit power;

12 reallocating each spatial subchannel in the saturation region with a revised
amount of transmit power;

14 determining a total excess transmit power for all spatial subchannels reallocated
with revised amounts of transmit power; and

16 performing the defining, determining, allocating, identifying, and reallocating
for one or more iterations, wherein the set of spatial subchannels for a first iteration
includes the plurality of spatial subchannels and for each subsequent iteration includes
18 spatial subchannels not in the saturation region, and wherein the total transmit power
available for each subsequent iteration includes the total excess transmit power
20 determined in a current iteration.

15. The method of claim 14, wherein the total transmit power available for
2 each iteration is allocated to the spatial subchannels in the set based on a water-filling
allocation scheme.

16. A method for allocating transmit power to a plurality of transmission
2 channels in a wireless communication system, comprising:

4 identifying a first set of transmission channels to be allocated transmit power;
determining a total transmit power available to allocate to the transmission
channels in the first set;

- 6 allocating the total transmit power to the transmission channels in the first set
based on a particular allocation scheme;
- 8 identifying a second set of one or more transmission channels allocated
excessive transmit power for preferred operating points;
- 10 allocating each transmission channel in the second set with a revised amount of
transmit power to achieve the preferred operating point;
- 12 determining a total excess power for all transmission channels in the second set;
- 14 identifying a third set of one or more transmission channels capable of
supporting higher preferred operating points; and
- 16 reallocating the total excess power to the one or more transmission channels in
the third set.

17. The method of 16, wherein each preferred operating point is associated
2 with a signal-to-noise ratio (SNR) needed to support a particular discrete data rate.

18. The method of 16, further comprising:
2 evaluating a plurality of possible reallocations of the total excess power to the
one or more transmission channels in the third set.

19. The method of 18, further comprising:
2 selecting a reallocation associated with a highest gain in throughput.

20. The method of 16, wherein the total excess power is reallocated, one
2 channel at a time, to the one or more transmission channels in the third set.

21. The method of 16, wherein each transmission channel is reallocated
2 sufficient transmit power to achieve a next higher preferred operating point.

22. The method of 16, wherein the reallocating includes
2 determining an amount of transmit power needed for each transmission channel
in the third set to achieve a next higher preferred operating point, and
4 reallocating the total excess power to the transmission channel associated with a
highest gain in throughput.

23. The method of 16, wherein the total transmit power is allocated to the
2 transmission channels in the first set based on a water-filling scheme.

24. The method of 16, wherein the plurality of transmission channels
2 correspond to spatial subchannels in a MIMO system.

25. The method of 16, wherein the plurality of transmission channels
2 correspond to frequency subchannels in an OFDM system.

26. The method of 16, wherein the plurality of transmission channels
2 correspond to frequency subchannels of spatial subchannels in a MIMO-OFDM system.

27. A method for allocating transmit power to a plurality of transmission
2 channels in a wireless communication system, comprising:

4 identifying a set of transmission channels to be allocated transmit power;

6 determining a total transmit power available to allocate to the transmission
channels;

8 allocating the total transmit power to the transmission channels in the set based
on a particular allocation scheme;

10 determining an excess spectral efficiency based in part on the transmit power
allocated to the transmission channels; and

12 reallocating one or more transmission channels with reduced amounts of
transmit power to reduce the excess spectral efficiency.

28. The method of 27, further comprising:

2 reducing the transmit power allocated to each transmission channel to achieve a
preferred operating point.

29. The method of 27, further comprising:

4 determining incremental changes in spectral efficiency for a plurality of transmit
power reductions for the transmission channels; and

6 selecting a largest transmit power reduction associated with an incremental
spectral efficiency change that is less than or equal to the excess spectral efficiency.

30. The method of 27, further comprising:

2 determining a backed-off transmit power; and

allocating the backed-off transmit power to the transmission channels in the set.

31. The method of 30, further comprising:

2 performing the determining the backed-off transmit power and the allocating the
backed-off transmit power one or more times until the excess spectral efficiency is
4 within a particular threshold.

32. A memory communicatively coupled to a digital signal processing

2 device (DSPD) capable of interpreting digital information to:

4 define a set of one or more transmission channels to be allocated transmit power;

6 determine a total transmit power available to allocate to the transmission
channels in the set;

8 allocate the total transmit power to the transmission channels in the set based on
a particular allocation scheme;

10 identify transmission channels in a saturation region resulting from the allocated
transmit power;

12 reallocate each transmission channel in the saturation region with a revised
amount of transmit power;

14 determine a total excess transmit power for all transmission channels reallocated
with revised amounts of transmit power; and

16 perform the define, determine, allocate, identify, and reallocate for one or more
iterations, wherein the set of transmission channels for a first iteration includes a
plurality of transmission channels in a wireless communication system and for each
subsequent iteration includes transmission channels not in the saturation region, and
18 wherein the total transmit power available for each subsequent iteration includes the
total excess transmit power determined in a current iteration.

33. A computer program product for allocating transmit power to a plurality

2 of transmission channels in a wireless communication system, comprising:

4 code for defining a set of one or more transmission channels to be allocated
transmit power;

code for determining a total transmit power available to allocate to the
6 transmission channels in the set;

code for allocating the total transmit power to the transmission channels in the
8 set based on a particular allocation scheme;

code for identifying transmission channels in a saturation region resulting from
10 the allocated transmit power;

code for reallocating each transmission channel in the saturation region with a
12 revised amount of transmit power;

code for determining a total excess transmit power for all transmission channels
14 reallocated with revised amounts of transmit power;

code for performing the defining, determining, allocating, identifying, and
16 reallocating for one or more iterations, wherein the set of transmission channels for a
first iteration includes the plurality of transmission channels and for each subsequent
18 iteration includes transmission channels not in the saturation region, and wherein the
total transmit power available for each subsequent iteration includes the total excess
20 transmit power determined in a current iteration; and

a computer-readable medium for storing the codes

34. An apparatus in a wireless communication system, comprising:

2 means for defining a set of one or more transmission channels to be allocated
transmit power;

4 means for determining a total transmit power available to allocate to the
transmission channels in the set;

6 means for allocating the total transmit power to the transmission channels in the
set based on a particular allocation scheme;

8 means for identifying transmission channels in a saturation region resulting from
the allocated transmit power;

10 means for reallocating each transmission channel in the saturation region with a
revised amount of transmit power;

12 means for determining a total excess transmit power for all transmission
channels reallocated with revised amounts of transmit power; and

14 means for performing the defining, determining, allocating, identifying, and
reallocating for one or more iterations, wherein the set of transmission channels for a
16 first iteration includes the plurality of transmission channels and for each subsequent

iteration includes transmission channels not in the saturation region, and wherein the
18 total transmit power available for each subsequent iteration includes the total excess
transmit power determined in a current iteration.

35. A controller in a wireless communication system, comprising:

2 means for defining a set of one or more transmission channels to be allocated
transmit power;

4 means for determining a total transmit power available to allocate to the
transmission channels in the set;

6 means for allocating the total transmit power to the transmission channels in the
set based on a particular allocation scheme;

8 means for identifying transmission channels in a saturation region resulting from
the allocated transmit power;

10 means for reallocating each transmission channel in the saturation region with a
revised amount of transmit power;

12 means for determining a total excess transmit power for all transmission
channels reallocated with revised amounts of transmit power; and

14 means for performing the defining, determining, allocating, identifying, and
reallocating for one or more iterations, wherein the set of transmission channels for a
16 first iteration includes the plurality of transmission channels and for each subsequent
iteration includes transmission channels not in the saturation region, and wherein the
18 total transmit power available for each subsequent iteration includes the total excess
transmit power determined in a current iteration.

36. The controller of claim 35, further comprising:

2 means for determining an effective signal-to-noise ratio (SNR) for each
transmission channel in the set based in part on the transmit power allocated to the
4 transmission channel;

6 means for comparing the effective SNR for each transmission channel in the set
to a threshold SNR applicable to the transmission channel; and

8 means for declaring a transmission channel as being in the saturation region if its
effective SNR is greater than the applicable threshold SNR.

37. A base station comprising the controller of claim 35.

38. A controller in a wireless communication system, comprising:

- 2 means for identifying a first set of transmission channels to be allocated transmit power;
- 4 means for determining a total transmit power available to allocate to the transmission channels in the first set;
- 6 means for allocating the total transmit power to the transmission channels in the first set based on a particular allocation scheme;
- 8 means for identifying a second set of one or more transmission channels allocated excessive transmit power for preferred operating points;
- 10 means for allocating each transmission channel in the second set with a revised amount of transmit power to achieve the preferred operating point;
- 12 means for determining a total excess power for all transmission channels in the second set;
- 14 means for identifying a third set of one or more transmission channels capable of supporting higher preferred operating points; and
- 16 means for reallocating the total excess power to the one or more transmission channels in the third set.

39. A controller in a wireless communication system, comprising:

- 2 means for identifying a set of transmission channels to be allocated transmit power;
- 4 means for determining a total transmit power available to allocate to the transmission channels;
- 6 means for allocating the total transmit power to the transmission channels in the set based on a particular allocation scheme;
- 8 means for determining an excess spectral efficiency based in part on the transmit power allocated to the transmission channels; and
- 10 means for reallocating one or more transmission channels with reduced amounts of transmit power to reduce the excess spectral efficiency.

40. A transmitter unit in a wireless communication system, comprising:

2 a transmit (TX) data processor operative to code data for a plurality of
4 transmission channels based on one or more coding and modulation schemes to provide
4 a plurality of streams of symbols;

6 a plurality of transmitters operative to process the plurality of symbol streams to
6 provide a plurality of modulated signals suitable for transmission over a communication
channel; and

8 a controller operative to allocate transmit power to the plurality of transmission
channels by

10 defining a set of one or more transmission channels to be allocated
transmit power,

12 determining a total transmit power available to allocate to the
transmission channels in the set,

14 allocating the total transmit power to the transmission channels in the set
based on a particular allocation scheme,

16 identifying transmission channels in a saturation region resulting from
the allocated transmit power,

18 reallocating each transmission channel in the saturation region with a
revised amount of transmit power,

20 determining a total excess transmit power for all transmission channels
reallocated with revised amounts of transmit power, and

22 performing the defining, determining, allocating, identifying, and
reallocating for one or more iterations, wherein the set of transmission channels
24 for a first iteration includes the plurality of transmission channels and for each
subsequent iteration includes transmission channels not in the saturation region,
26 and wherein the total transmit power available for each subsequent iteration
includes the total excess transmit power determined in a current iteration.

41. The transmitter unit of claim 40, wherein the TX data processor is further
2 operative to scale each modulation symbol with a particular weight determined based on
the transmit power allocated to the transmission channel used for the modulation
4 symbol.

42. The transmitter unit of claim 40, further comprising:

2 a MIMO processor operative to pre-condition the plurality of symbol streams to
diagonalize the plurality of transmission channels.

43. A base station comprising the transmitter unit of claim 40.

44. A receiver unit in a wireless communication system, comprising:
2 a receive (RX) MIMO processor operative to receive and process a plurality of
streams of samples to provide a plurality of streams of received symbols, and to derive
4 channel state information (CSI) for a plurality of transmission channels used for the
plurality of received symbol streams; and

6 a RX data processor operative to process the plurality of received symbol
streams in accordance with one or more demodulation and decoding schemes to provide
8 decoded data, and

10 wherein transmit power for the plurality of transmission channels is allocated
based in part on the CSI by allocating a total available transmit power to the plurality of
12 transmission channels based on a particular allocation scheme, reallocating each
14 transmission channel in a saturation region with a revised amount of transmit power,
and allocating total remaining transmit power to transmission channels not in the
saturation region.

45. The receiver unit of claim 44, wherein the RX MIMO processor is
2 further operative to pre-condition the plurality of received symbol streams to
diagonalize the plurality of transmission channels.

46. The receiver unit of claim 44, further comprising:
2 a TX data processor operative to process the CSI for transmission back to a
transmitter unit.

47. A receiver apparatus in a wireless communication system, comprising:
2 means for processing a plurality of streams of samples to provide a plurality of
streams of received symbols, and to derive channel state information (CSI) for a
4 plurality of transmission channels used for the plurality of received symbol streams; and
means for processing the plurality of received symbol streams in accordance
6 with one or more demodulation and decoding schemes to provide decoded data, and

wherein transmit power for the plurality of transmission channels is allocated
8 based in part on the CSI by allocating a total available transmit power to the plurality of
transmission channels based on a particular allocation scheme, reallocating each
10 transmission channel in a saturation region with a revised amount of transmit power,
and allocating total remaining transmit power to transmission channels not in the
12 saturation region.